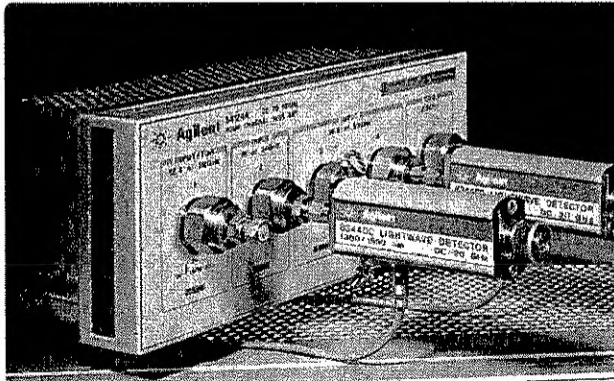


# Agilent 83440B/C/D High-Speed Lightwave Converters

DC-6/20/30 GHz, 1000 to 1600 nm

## Technical Specifications



**Fast optical detector  
for characterizing  
lightwave signals**

- Fast 15, 22, or 73 ps full-width half-max (FWHM) pulse response
- Broad 6, 20, or 30 GHz bandwidth (3 dB<sub>opt</sub>)
- Small, convenient package
- Low pulse aberrations
- Integral bias regulation
- Ideal for high-speed digitizing oscilloscopes

Make lightwave measurements with traditional electrical instruments; the Agilent 83440 family offers a high-speed optical interface for oscilloscopes, spectrum analyzers, and network analyzers.

With as low as 15 ps FWHM pulse response, the 83440 accurately converts modulated optical waveforms to electrical signals, enabling electrical instruments to measure time domain pulse parameters and frequency domain spectral content. Characterize and optimize laser and optical modulator output performance for fiber optic telecommunications.

### Description

The 83440 lightwave converters are fast, accurate, DC-coupled optical-to-electrical (O/E) converters packaged as small optical probes. They mount directly to electrical instrument front panels to simplify integration and minimize distortion and loss from cables, connectors, and signal conditioning components. A simple internal structure ensures very low signal distortion for improved output signal fidelity. By eliminating all unnecessary components along the signal path, the 83440 family offers very accurate electrical representations of modulated optical waveforms. The 83440 family features hermetically sealed, unamplified, InGaAs photodiodes. The input optical port features the Agilent universal optical interface, compatible with most common optical connectors (see Connectors, page 6), while the output electrical port features a precision 3.5 mm (83440B/C) or 2.4 mm (83440D) microwave coaxial connector.

### Time Domain Applications

Ideal for high-speed laser and modulator testing, the DC-coupled 83440 family faithfully reproduces incoming optical signals for accurate pulse parameter characterization. Broad bandwidth, nearly Gaussian response characteristics, and low pulse aberrations make these optical detectors an excellent choice for high-speed time domain measurements.

### Frequency Domain Applications

The frequency domain allows users to measure, quantify, and model modulated characteristics such as spectral purity, harmonic content, and noise spectral density. The 83440 family allows electrical frequency domain instruments like network and spectrum analyzers to accept optical input signals for basic lightwave measurements.



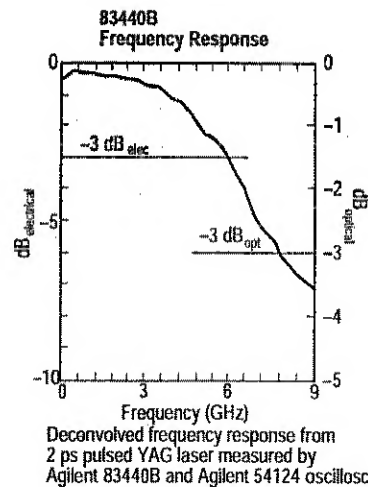
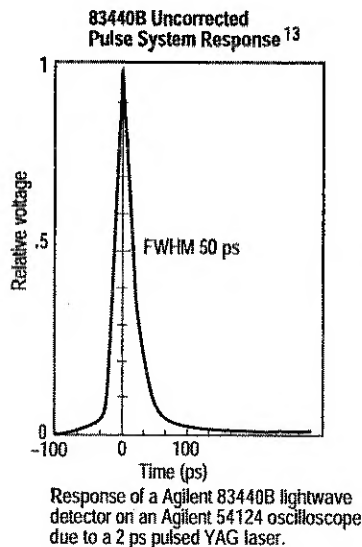
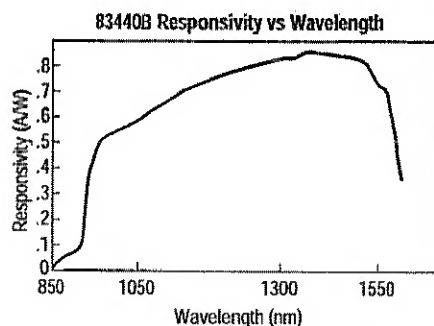
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# Agilent 83440B

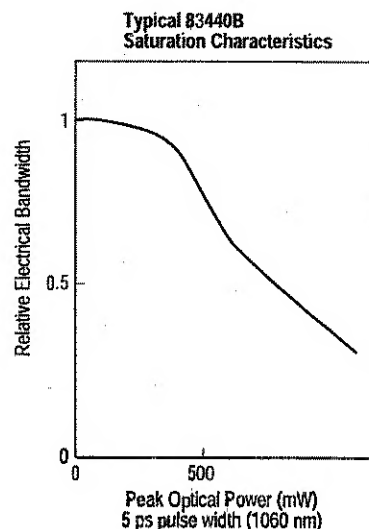
## Specifications and Characteristics

Specifications describe the instrument's warranted performance over the temperature range 0 to 55°C (except where noted). Supplemental Characteristics are intended to provide information useful in applying the instrument by giving typical but non-warranted performance parameters. These are denoted as "typical," "nominal," or "approximate."

### Typical Response Curves



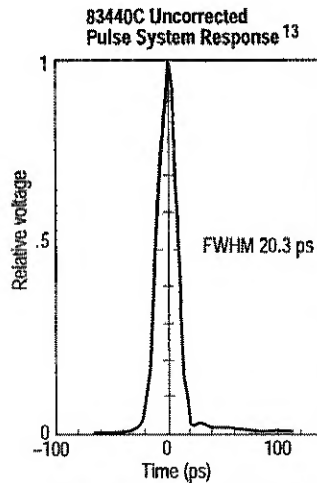
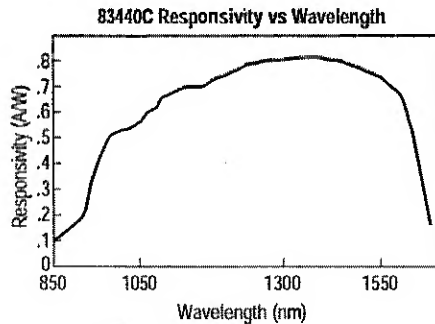
Time Domain	Frequency Domain
<b>Conversion Gain<sup>1,4</sup></b> (min, into 50 $\Omega$ load) 1300 nm: 35 V/W      1550 nm: 32.5 V/W	<b>DC Responsivity<sup>1,4</sup></b> (min) 1300 nm      1550 nm 0.70 A/W      0.65 A/W -3.1 dB <sup>2</sup> -3.7 dB <sup>2</sup> 0.33 A/W      0.30 A/W -9.6 dB <sup>2</sup> -10.5 dB <sup>2</sup>
<b>Opt 050:</b> 18.5 V/W      15 V/W	
<b>Pulse Width<sup>3,4,10</sup></b> < 73 ps FWHM <sup>6</sup> (calculated: FWHM = 0.44/BW <sub>opt</sub> = 0.312/BW <sub>el</sub> )	<b>Bandwidth<sup>3,4</sup></b> dc to >6 GHz (-3dB optical)
<b>Rise/Fall Time<sup>7,10</sup></b> (10-90%) < 80ps (calculated)	
<b>System Aberrations<sup>4,13</sup></b> (response to 2 ps FWHM pulse) 10% peak-to-peak max, 5% typical	
<b>Noise<sup>5,11</sup></b> 2 $\mu$ W RMS max, equivalent optical noise power	<b>Noise Equivalent Power<sup>5,11</sup></b> < 18 pW/ $\sqrt{\text{Hz}}$ typical
<b>Dark Current<sup>11</sup></b> 50 nA max, <15 nA typical	
<b>Maximum Safe Input Optical Power</b> 10 mW (Peak)      +10 dBm (Peak)	
<b>Maximum Operating Input Optical Power (Compression Point)</b> 2 mW (Peak)      +3 dBm (Peak) See saturation chart for pulsed power characteristics	
<b>Input Optical Reflection<sup>8</sup></b> (HMS-10 optical connector) 0.05% (1250-1600 nm)	<b>Input Optical Return Loss<sup>8</sup></b> (HMS-10 optical connector) >33 dB (1250-1600 nm)
<b>Wavelength Spectral Response<sup>4</sup></b> 1000 nm - 1600 nm	



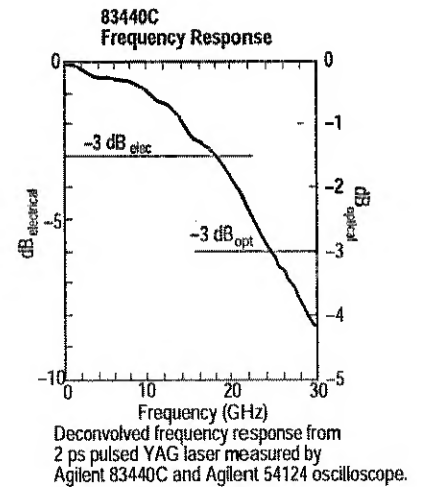
# Agilent 83440C Specifications and Characteristics

Specifications describe the instrument's warranted performance over the temperature range 0 to 55°C (except where noted). Supplemental Characteristics are intended to provide information useful in applying the instrument by giving typical but non-warranted performance parameters. These are denoted as "typical," "nominal," or "approximate."

## Typical Response Curves

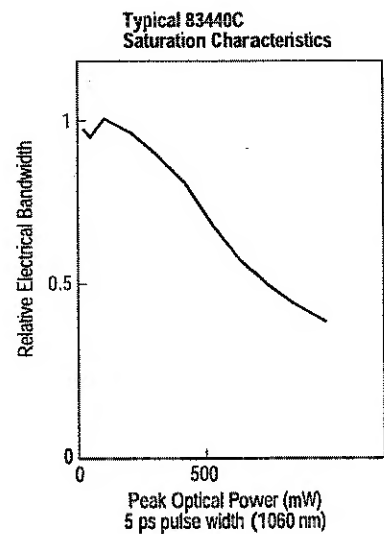


Response of a Agilent 83440C lightwave detector on an Agilent 54124 oscilloscope due to a 2 ps pulsed YAG laser.



Deconvolved frequency response from 2 ps pulsed YAG laser measured by Agilent 83440C and Agilent 54124 oscilloscope.

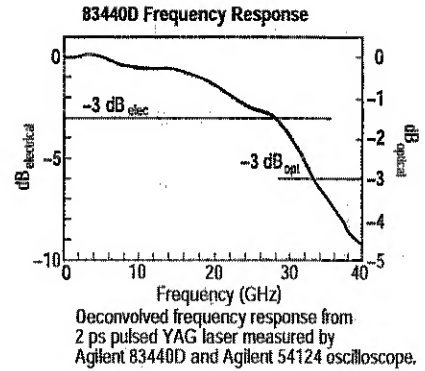
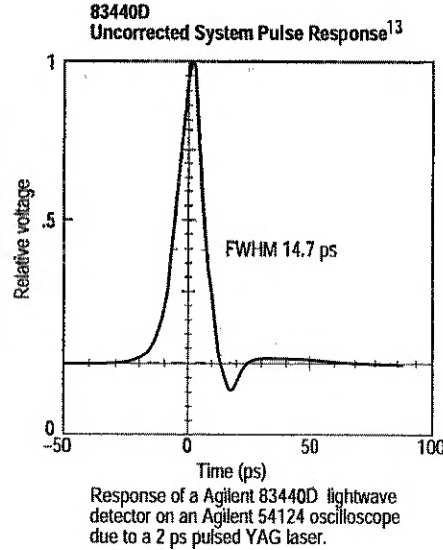
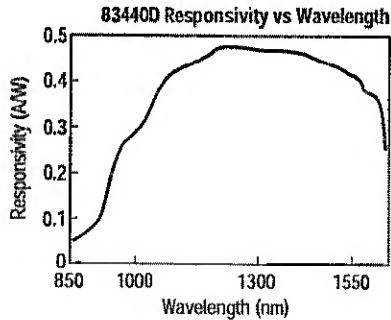
Time Domain	Frequency Domain
<b>Conversion Gain<sup>1,4</sup></b> (min, into 50 $\Omega$ load) 1300 nm: 35 V/W      1550 nm: 32.5 V/W	<b>DC Responsivity<sup>1,4</sup></b> (min) 1300 nm      1550 nm 0.70 A/W      0.65 A/W -3.1 dB <sup>2</sup> -3.7 dB <sup>2</sup>
<b>Pulse Width<sup>3,4,10</sup></b> < 22 ps FWHM <sup>6</sup> (calculated; FWHM=0.44/BW <sub>opt</sub> =0.312/BW <sub>el</sub> )	<b>Bandwidth<sup>3,4</sup></b> dc to >20 GHz (-3dB optical)
<b>Rise/Fall Time<sup>7,10</sup></b> (10-90%) <24ps (calculated)	
<b>System Aberrations<sup>4,13</sup></b> (response to 2 ps FWHM pulse) 10% peak-to-peak max, 5% typical	
<b>Noise<sup>5,11</sup></b> 3.7 $\mu$ W RMS max, equivalent optical noise power	<b>Noise Equivalent Power<sup>5,11</sup></b> < 18 pW/ $\sqrt{\text{Hz}}$ typical
<b>Dark Current<sup>11</sup></b> 20 nA max, 3 nA typical	
<b>Maximum Safe Input Optical Power</b> 10 mW (Peak)      +10 dBm (Peak)	
<b>Maximum Operating Input Optical Power (Compression Point)</b> 2 mW (Peak)      +3 dBm (Peak) See saturation chart for pulsed power characteristics	
<b>Input Optical Reflection<sup>8</sup></b> (HMS-10 optical connector) 0.05% (1250-1600 nm)	<b>Input Optical Return Loss<sup>8</sup></b> (HMS-10 optical connector) >33 dB (1250-1600 nm)
<b>Wavelength Spectral Response<sup>4</sup></b> 1000 nm - 1600 nm	



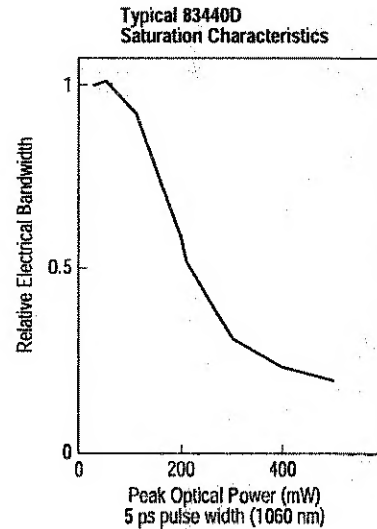
# Agilent 83440D Specifications and Characteristics

Specifications describe the instrument's warranted performance over the temperature range 0 to 55°C (except where noted). Supplemental Characteristics are intended to provide information useful in applying the instrument by giving typical but non-warranted performance parameters. These are denoted as "typical," "nominal," or "approximate."

## Typical Response Curves



Time Domain	Frequency Domain
<b>Conversion Gain<sup>1,4</sup></b> (min into 50 $\Omega$ load) 1300 nm: 20 V/W    1550 nm: 15 V/W	<b>DC Responsivity<sup>1,4</sup></b> (min) 1300 nm    1550 nm 0.3 A/W    0.3 A/W -8 dB <sup>2</sup> -10.5 dB <sup>2</sup>
<b>Pulse Width<sup>4,10,14</sup></b> (calculated: FWHM=0.44/BW <sub>opt</sub> =0.312/BW <sub>el</sub> ) < 13 ps FWHM <sup>6</sup>	<b>Bandwidth<sup>4,12,14</sup></b> dc to 30 GHz nominal (-3dB optical)
<b>Rise/Fall Time<sup>7,10</sup></b> (10-90%) < 16 ps (calculated)	
<b>System Aberrations<sup>4,13</sup></b> (response to 2 ps FWHM pulse) 20% peak-to-peak max, <12% typical	
<b>Noise<sup>5,11</sup></b> 8.1 $\mu$ W RMS max, equivalent optical noise power	<b>Noise Equivalent Power<sup>5,11</sup></b> < 18 pW/ $\sqrt{\text{Hz}}$ typical
<b>Dark Current<sup>11</sup></b> 20 nA max, 4 nA typical	
<b>Maximum Safe Input Optical Power</b> 10 mW (Peak)    +10 dBm (Peak)	
<b>Maximum Operating Input Optical Power (Compression Point)</b> 2 mW (Peak)    +3 dBm (Peak) See saturation chart for pulsed power characteristics	
<b>Input Optical Reflection<sup>8</sup></b> (HMS-10 optical connector) 0.10 % (1250-1600 nm)	<b>Input Optical Return Loss<sup>8</sup></b> (HMS-10 optical connector) >30 dB (1250-1600 nm)
<b>Wavelength Spectral Response<sup>4</sup></b> 1000 nm - 1600 nm	



## Using the Agilent 83440B/C/D Lightwave Converter

### O/E Conversion Process

The 83440 detects the modulated baseband signal from the lightwave carrier, converting it to an electrical signal for processing. The resultant electrical signal can be analyzed in the time domain or frequency domain using electrical oscilloscopes, signal analyzers, and network analyzers. The 83440B/C/D are DC coupled receivers. For proper operation, a DC path to ground is necessary at the RF output. When using the 83440 with an AC-coupled instrument (except opt 050), a bias tee such as the 11612A is required to supply dc bias return path. Alternatively, an attenuator on the output may be used to provide a dc bias return path.

### Supplying +15V to the 83440

Depending on the instruments that the Agilent 83440 will be used with, there are several possible configurations to supply the needed +15V bias voltage to the 83440:

**86100B:** Use the 83440-60004 cable to connect to the +15V supply at the rear of the 86100B

**Agilent Network Analyzers with Probe Power:** Use the 83440-60006 cable to connect to the Probe Power Port of the network analyzer.

**87421A Power Supply:** Use the 83440-60009 cable in series with the 83440-60004 to connect to the power supply

**11899A Probe Power Supply:** Use the 83440-60006 cable to connect to the stand-alone probe power supply.

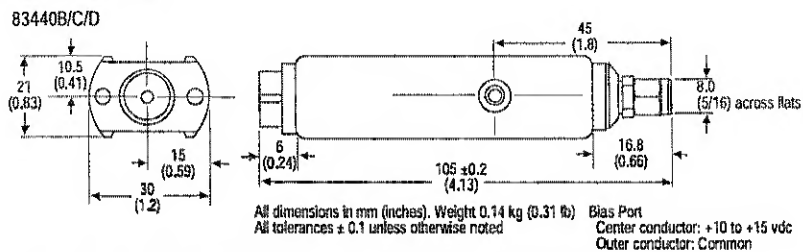
**General Purpose Variable Power Supply:** Use the 83440-60005 cable in series with the 83440-60004 cable.

## Physical Characteristics

### General

RF Connector	Agilent 83440B/C (3.5 mm [m]) or 83440D (2.4 mm [m]), 50Ω
ESD Susceptibility at RF Pin <sup>9</sup>	200 V
DC Bias Voltage	+10 to +15V dc required
Power Consumption	< 18 mVA
Weight	0.14 kg (0.31 lb)
Operating Temperature	0-55 deg C
Compatible Fiber	9/125 single mode fiber
Photodiode Package	Hermetically sealed PIN-diode
Output Impedance	Unterminated (50Ω terminated for Agilent 83440B Opt 050)
Calibration	Recommended calibration interval is two years.

### Mechanical



### Connectors

#### Optical Input:

*Specify optical input connector option when ordering Agilent 83440B/C/D.*

81000 AI	Diamond HMS-10
81000FI	FC/PC connector
81000 SI	DIN 47256 connector
81000 VI	ST connector
81000 KI	SC connector

#### Electrical Output:

3.5 mm (83440B/C)  
2.4 mm (83440D)

**DC Bias Input:** Quick connect (LEMO) bias port

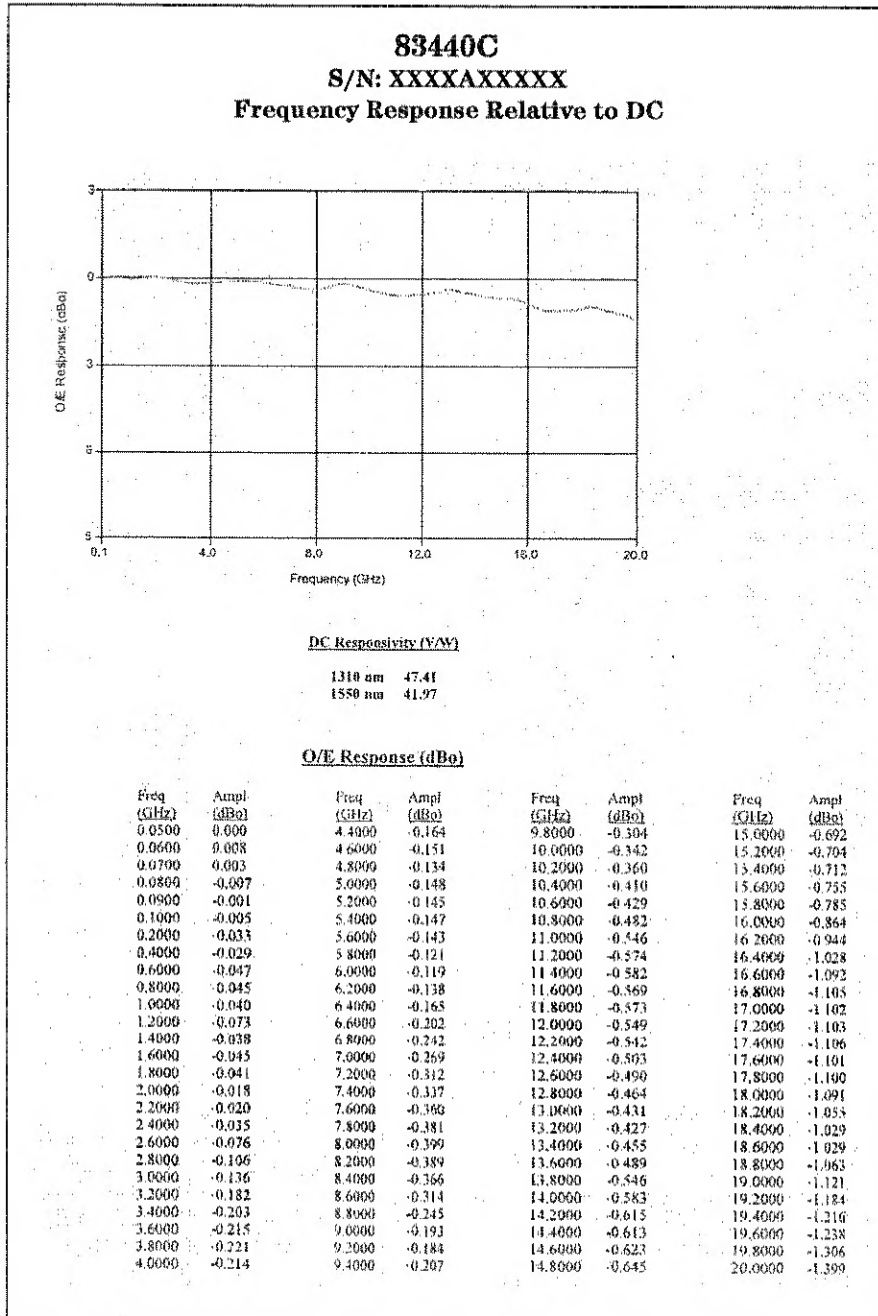
#### ESD Sensitive Parts<sup>9</sup>

The 83440 features a captive RF connector cap to protect the RF center pin from electrostatic discharge (ESD). Use proper ESD precautions when working with RF and bias ports. *Keep RF port capped when not in use.*

## Shipping Contents

- One 83440 Lightwave Detector with response data sheet (example shown below)
- User specified optical connector adapter
- Three dc bias cables (83440-60004, 83440-60005, 83440-60006)

Each 83440 is shipped with instrument-specific frequency response and conversion gain (dc responsivity) data.



## Ordering Information

### Agilent 83440B DC-6 GHz Lightwave Converter

83440B-050, 50Ω termination for use with SDH/SONET filters

### Agilent 83440C DC-20 GHz Lightwave Converter

### Agilent 83440D DC-30 GHz Lightwave Converter

Note: All 83440 orders must specify an optical connector option.

## Recommended Accessories

87421A	External 15V fixed power supply
11899A	External probe power supply
8493C-003, 006	3.5 mm fixed attenuators (3 dB and 6 dB respectively)
11901D	2,4 mm (f) to 3.5 mm (m) coax adapter
1250-1391	SMB-tee
11612A	3.5 mm bias network (45 MHz–26.5 GHz)
5952-9654	Fiber Optics Handbook

## DC Bias Cables

83440-60004	SMB (f) to quick connect (LEMO)
83440-60005	SMB (m) to bare wire (ground = black, +15V = clear)
83440-60006	3-pin half-round (f) to quick connect (LEMO)
83440-60009	9-pin D-sub (m) to SMB (m)

## Other Agilent O/E Converters

Agilent 11982A	DC–15 GHz <i>amplified</i> converter. 300 V/W conversion gain. Product Overview lit. no. 5966-1583E.
Agilent 83410C	300 kHz–3 GHz <i>amplified</i> receiver (62.5/125 μm fiber). Technical Specifications lit. no. 5988-4308EN.
Agilent 83411A	300 kHz–6 GHz receiver (62.5/125 μm fiber). Technical Specifications lit. no. 5988-4308EN.
Agilent 83411B	300 kHz–6 GHz <i>amplified</i> receiver (62.5/125 μm fiber). Technical Specifications lit. no. 5988-4308EN.
Agilent 83412A	300 kHz–3 GHz <i>amplified</i> receiver (850 nm) (62.5/125 μm fiber). Technical Specifications lit. no. 5988-4308EN.
Agilent 83434A	10 Gb/s lightwave clock and data receiver. Product Overview lit. no. 5968-9251E.
Agilent 83446A/B	2.4 Gb/s lightwave clock and data receiver. Product Overview lit. no. 5962-1682E.

## Notes

- <sup>1</sup> Stated specs from 83440B/C/D into 50Ω load.
- <sup>2</sup> For an O/E device, responsivity (dB) = 20log [  $\frac{\text{responsivity A/W}}{1 \text{ A/W}}$  ]
- <sup>3</sup> Measured on 8703A lightwave component analyzer. Frequency response verified by deconvolving impulse response of 83440C on 54124 oscilloscope due to a 2 ps pulse YAG laser.
- <sup>4</sup> See typical performance trace.
- <sup>5</sup> Thermal noise limited; equivalent optical power limited by 50 Ω input impedance.
- <sup>6</sup> Full-Width Half-Max.
- <sup>7</sup> Calculated from bandwidth measurements;  $\tau_r = \frac{.48}{\text{BW}_{\text{opt}}} \left( \approx \frac{.34}{\text{BW}_{\text{elec}}} \right)$  Calculation assumes Gaussian pulse.
- <sup>8</sup> Optical connector limited.
- <sup>9</sup> ESD susceptibility limited to RF connector center pin. Overall package (other than bias port and RF connector) withstands >25,000 V ESD.
- <sup>10</sup> Impulse response calculations verified using 2 ps pulsed YAG laser.
- <sup>11</sup> At room temperature ( 23°C ± 3°C )
- <sup>12</sup> All 83440D units are tested for 30 GHz minimum bandwidth. Measured frequency response data is supplied with each unit.
- <sup>13</sup> Uncorrected *System* aberrations include oscilloscope response and source laser aberrations from 2 ps pulsed YAG laser system. Slower pulse width will generate lower aberration levels; high 83440D detector bandwidth can excite 50 GHz oscilloscope response.
- <sup>14</sup> 83440D test system consists of 2-3 ps compressed Nd:YAG laser and 54124 50 GHz digitizing oscilloscope. 83440D frequency response is derived from Fourier transform after correcting for oscilloscope and input pulse frequency response. System verified with YAG heterodyne.

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